APPENDIX C

ENGINE INVENTORY

I. Introduction

In 2001 Air Resources Board (ARB) staff conducted a survey of solid waste collection vehicles (collection vehicles) in California, gathering engine and fleet data for approximately 70 percent of the fleet. The data were used to create the Diesel Retrofit Implementation and Evaluation Database (DRIED 2001). Before this survey, no aggregate data existed on the engines used in collection vehicles. ARB's emission inventory for heavy-duty vehicles is assembled on a vehicle level. Best available control technology is applied to the engine and vehicle combination, thus it is critical to understand the inventory of engines, in addition to the inventory of vehicles.

As with other heavy-duty vehicles, the make of a collection vehicle does not necessarily correlate with a specific engine make. Typically, a collection vehicle is put together piece by piece; thus two collection vehicles with Freightliner chassis could have engines manufactured by two different companies. In addition, each engine may have different specifications, such as horsepower and displacement, resulting in different operating characteristics, leading to different likelihood of successful application of passive diesel particulate filters. Vehicle owners also rebuild, replace, and repower engines periodically over the life of the vehicle. Thus the engine model year may not correspond to the vehicle or chassis model year.

II. Methodology

A. Databases

To construct DRIED 2001, we began with a search of other databases to determine if useful data for collection vehicles existed. Two main databases were used to obtain fleet names, owner contact information, and approximate fleet sizes. This information was used to contact fleet owners, to correlate with data collected by ARB, and to supply some additional specific collection vehicle data. The two main sources of this type of information are databases maintained by the California Department of Motor Vehicles and California Highway Patrol.

1. California Department of Motor Vehicles

The California Department of Motor Vehicles (DMV) database contains vehicle and owner information. The DMV database, therefore, was not used to establish the engine information database, although it provided a valuable comparison for the database ARB staff created.

2. California Highway Patrol By Identification Terminal

The California Highway Patrol By Identification Terminal (CHP BIT) database lists vehicles in a fleet by terminal and carrier identification number and simplifies identification of solid waste collection companies by listing the fleet by company name, not by individual vehicle owners. To compile a list of companies involved in the solid waste collection industry in California, we used this database in conjunction with other specialized lists.

3. Other Sources of Data

Specialized sources of data included the list of collection vehicle owners in the South Coast Air Basin obtained from South Coast Air Quality Management District (SCAQMD) and the membership list of the California Refuse Removal Council (CRRC). In addition, staff searched Internet yellow pages and verified lists of company owners and fleets with the California Trucking Association and CRRC.

B. Data Collection Survey

Staff developed a form and cover letter to collect engine data for companies involved in solid waste collection in California. To distribute the survey and gain cooperation, staff attended local solid waste collection association meetings, contacted fleet owners and managers by mail, telephone and direct site visits, posted the request for data on the Diesel Risk Reduction Program web site, and requested assistance in collecting data at each workshop. Staff followed up several times and worked with fleet owners to assist them in compiling the data, if requested. The return rate was high overall.

C. Confidentiality

A major concern early on was confidentiality of the data. Many owners stated they would not submit data unless they were assured their data would be kept confidential. Collection vehicle owners did not want other companies to gain access to their information. Staff consulted with ARB's legal office and determined company-level data could be kept confidential and was not reachable under the California Public Records Act. All company-level results from this survey, therefore, are confidential and only summary data are disseminated in aggregate form.

D. Software

Microsoft Access 2000 software was used to compile and analyze data. The fields in DRIED 2001 included contact, engine, and data entry data (**Figure 1**).

Figure 1. Fields in DRIED 2001.

Contact Information
Date
Type of Business
Fleet Type
Business Name
Alias
Parent Business Name
Carrier ID
Terminal ID
Business Address
City
State
Contact Name
Telephone Area Code
Telephone Number
Fax Area Code
Fax Number
E-Mail

Collection Vehicle Engine Data
Engine Manufacturer
Engine Model
Engine Model Year
Horsepower Range
Displacement
Auxiliary Engine
Fuel Type
Manual or Electronic Fuel Injection
Vehicle Usage/Application
Total Inventory
Data Entry

Survey Form Completed
Date Received
Date Input
Data Enterer

E. Quality Control

In order to assure accuracy in DRIED 2001, staff established a quality control procedure. First, each morning the data receiver entered form receipt information, checking a box on the data collection form in the database and selecting "refuse-general" for the “Business Type” field. In so doing, she verified those companies were in the database. She wrote, "REC'D" on the form, and distributed the updated “Forms Completed Report” to each of the team members for inventory confirmation.

Twice a week the data entry operator entered the engine data from the forms into the database. He double-checked each entry before dating and initialing that he had entered the data on the form. He also entered his initials and the date on the database form. He then deposited the completed forms in a special folder.

Once a week the data checker triple checked for accuracy the critical form information in the database: engine manufacturer, engine model year, and total inventory. After checking the information, she put a check mark on the form and placed the form in the final “forms completed” folder.

III. Results and Discussion

Analysis of the inventory was used to determine the fleet composition for the engine exhaust temperature and fleet maintenance studies as well as for predicting retrofit feasibility for California's collection vehicles. The results are discussed in this section and were communicated to ARB's emission inventory group.

As shown by the survey, Cummins is the most popular engine manufacturer for collection vehicles, with 65 percent of the market (**Figure 2**). Volvo and Caterpillar make up the next significant market share, with 13 and 12 percent respectively. Detroit Diesel, International/Navistar, and Mack comprised 9 percent of the fleet together.

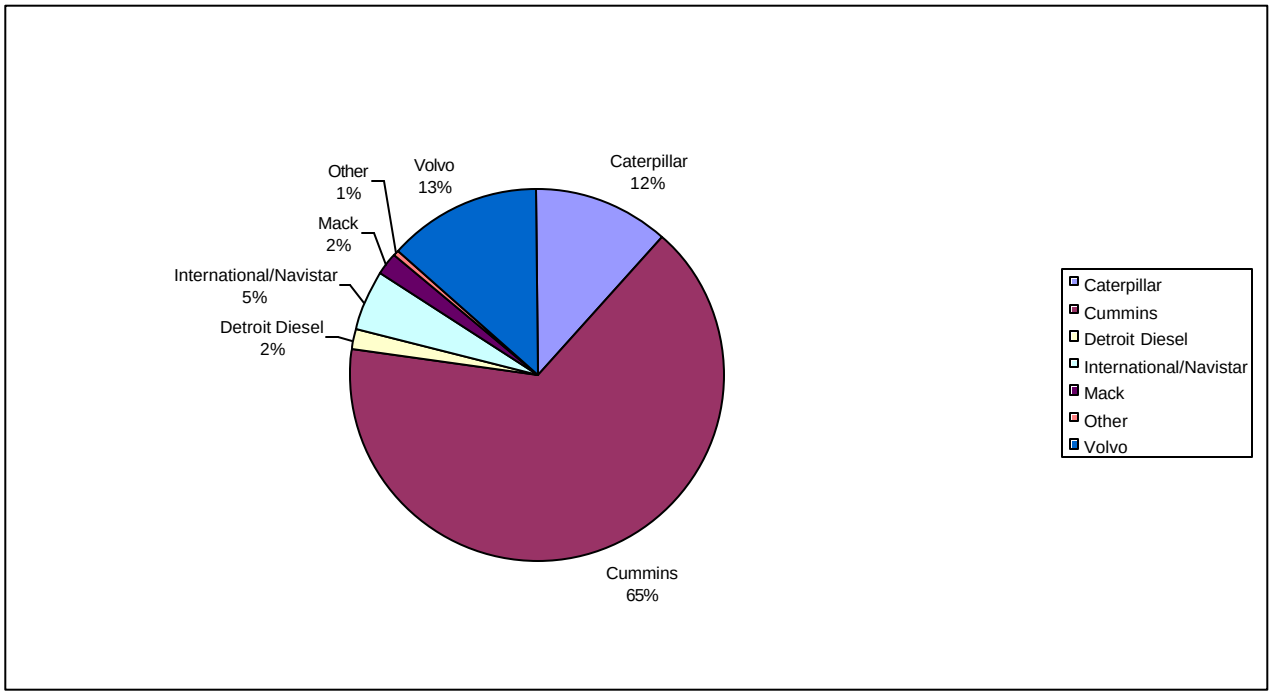

Figure 2. Percentage of Fleet by Engine Manufacturer

Four main types of vehicles are covered by the proposed regulation: front end, rear and side loaders, and rolloffs (**Figure 3**). Side loaders comprise the largest segment of the fleet with 39 percent of the vehicles, followed by rear (29 percent) and front end (25 percent) loaders. Rolloffs comprised the smallest segment of the fleet with only seven percent.

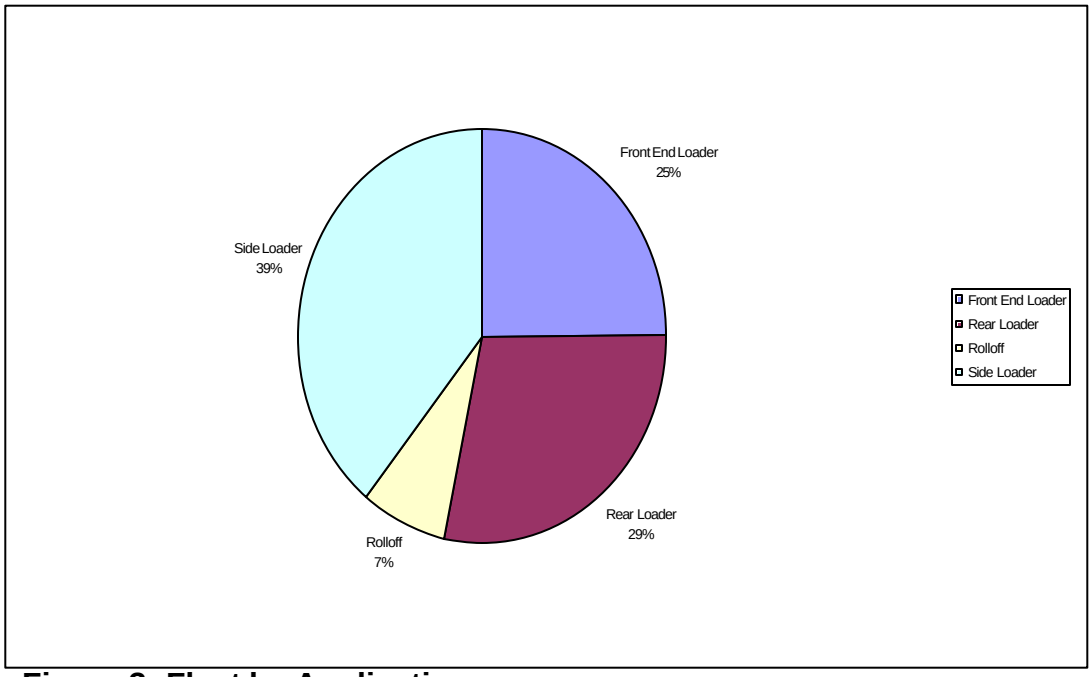

Figure 3. Fleet by Application

Staff also analyzed the fleet by engine model year (**Figure 4**). The age distribution spans over three decades, extending from 2002 back to 1966 engine model years. The fleet distribution by engine model year is tri-modal with peaks at engine model years 1989, 1995, and 2000.

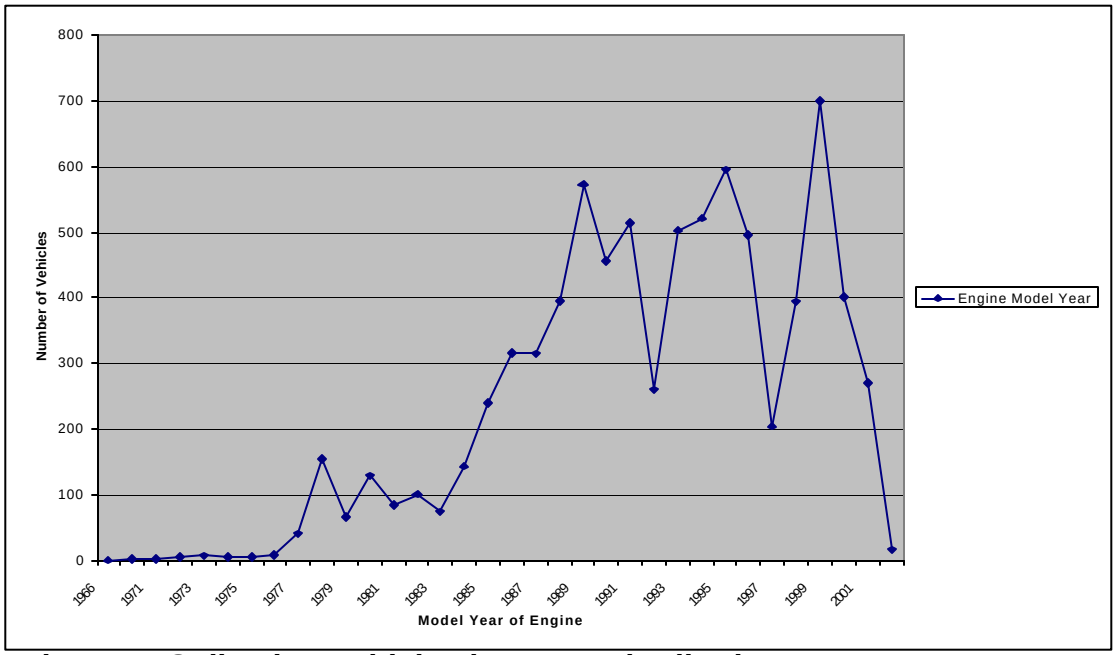

Figure 4. Collection Vehicle Fleet Age Distribution

Four main categories of engine PM emission standards exist for heavy-duty diesel-fueled engines. The first category is pre-1988 engine model years that were not regulated for PM emissions. The second category is 1988 to 1990 engine model years with a PM emission standard of 0.6 grams per brakehorsepower-hour (g/bhp-hr). Since then, the standards have been tightened twice, first in 1991 to 0.25 g/bhp-hr and then again in 1994 to 0.1 g/bhp-hr. The largest percentage, 45 percent, of the statewide collection vehicle fleet consists of 1994 to 2002 model year engines (**Figure 5**). The rest of the fleet is distributed approximately evenly among the three other PM categories.

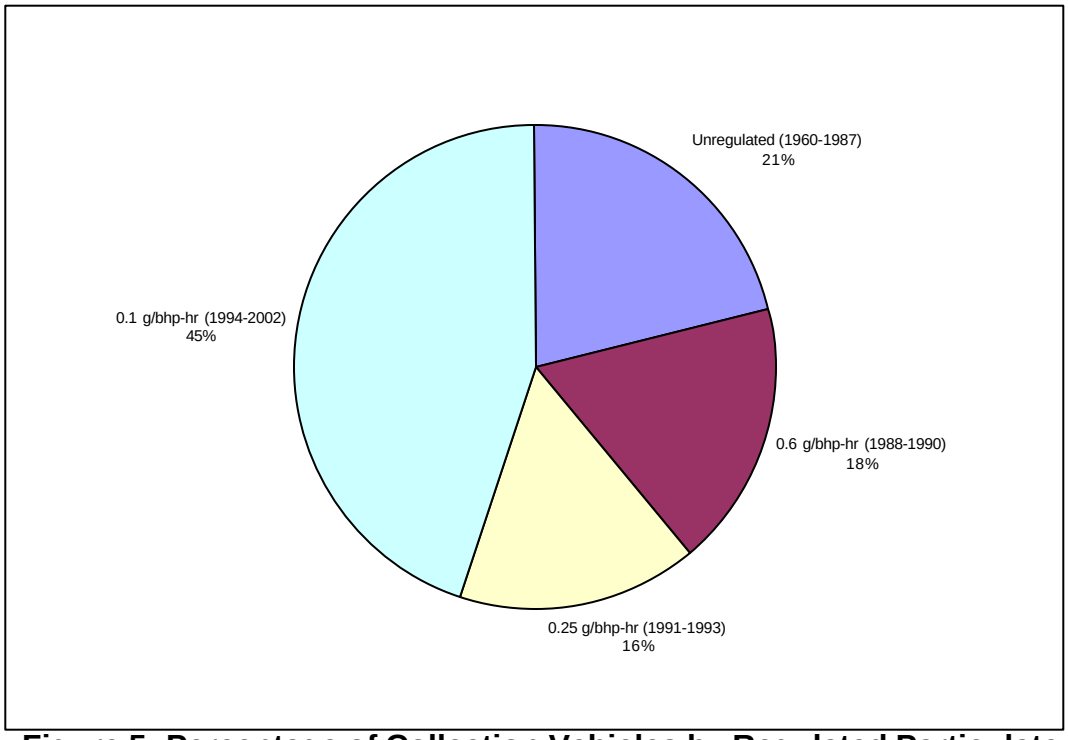

Figure 5. Percentage of Collection Vehicles by Regulated Particulate Emission Standard